Fiber Optic Repair and Maintainability (FORM) Program Progresses

Advanced aircraft will employ fiber-optic interconnection components to transmit information from airframe and propulsion sensors to the flight control computers. Although these optical interconnects have been rigorously tested under laboratory conditions to determine their operating and environmental limits, there is concern as to their repairability and maintainability when placed in actual service.

The Fiber Optic Repair and Maintainability (FORM) flight test program will provide data to enable designers to improve these fiber-optic interconnection systems for the next generation of aircraft. FORM is identifying critical problems in installing, maintaining, testing, and repairing fiber-optic interconnection systems in an operational avionics environment. This program is a cooperative Government/industry effort to evaluate optical component acceptability and installation techniques for aircraft.

FORM, which began in 1994, has three phases spanning a 3-year period where approximately 250 flight test hours will be accumulated on experimental fiber-optic components. In Phase I, a total of 60 flight hours were accumulated on fiber-optic harnesses and connectors installed onboard the OV-10 aircraft at the NASA Lewis Research Center. This phase was funded by Lewis and Navy Crane, where several participants from the aerospace industry (Sikorsky Aircraft, Amphenol, and Deutsch) supplied the test hardware.

An additional 90 flight hours were accumulated in Phase II, which was funded by the Fly-by-Light/Power-by-Wire program at Lewis. As part of this effort, additional fiber-optic harnesses, provided by Sikorsky Aircraft and Lockheed Corporation, and optical splices, provided by Aurora Optics, were installed on the aircraft. To date, FORM has flown over 150 hours.

To route the fiber-optic harnesses through the aircraft, we mounted ¾-in. convoluted conduit through the OV-10 cargo bay, fuselage, wing, boom, and horizontal stabilizer. We compared split and nonsplit conduit installation by running separate segments side-by-side along the cargo bay and fuselage areas. Another run of nonsplit conduit extends through the booms to the horizontal stabilizer and back to the cargo bay. In all installations, the conduit was partially filled with electrical wire to reproduce actual aircraft conditions.

Once the conduit was completely installed and secured, two methods of fiber-optic harness installation were tested. The first method pulls the harnesses through the conduit with a jet line/pull wire that extends the entire length inside the conduit. One end is attached to the fiber-optic harness and then pulled from the other. The second method slips the optical cables into the split conduit. Although split conduit provides easy access to the harnesses, it requires more time to feed fibers through than the nonsplit conduit does. The nonsplit conduit provides more protection to the fibers, as well as ease of installation and removal.

The harnesses were flown unmated for portions of the tests to expose the fiber-optic connectors to contaminants present in normal aircraft environment. Transmissive loss measurements were taken before and after cleaning the connectors during this procedure.

Phase III of FORM will test optical data bus transmission and the electro-optical transmission and reception units. It will demonstrate actual data bus transmission through a 1773 optical data bus segment on the OV-10. The current 1553 data bus on the aircraft will be modified to include the 1773 segment in its data path. All the installation and test information collected in this program will be actively transferred to the private vendors for implementation in their ongoing programs, such as Sikorsky's Comanche program, Lockheed's Red Eye, and the F-22 programs.

The NASA OV-10 aircraft used for this test is a twin-engine, two-crew-member, tandem seating turboprop aircraft. It has a top airspeed of 350 kn, a maximum altitude of 30,000 ft, and acceleration limits from -1.0 to 4.5g.

NASA OV-10 research aircraft.

The OV-10 flight test profiles for this program follow:

- Profile I: Low-altitude navigation (below 5000 ft) at maximum continuous power with numerous accelerated turns and with 3.0 to 4.5g maneuvers in turbulent atmospheric conditions
- Profile II: High-altitude navigation (above 21,000 ft)
- Profile III: Multiple takeoffs, approaches, and landings